USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2006CA168B

Title: Ecohydrologic Effects of Stream Restoration

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Principal Investigator: Mount, Jeffrey

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Abstract: Ecologic and hydrologic conditions in rivers and streams throughout the developed world have been degraded by changes in land use and water management activites. One cause of river degradation is channelization, which alters the functions of riparian and floodplain wetlands by fundamentally changing the hydrologic, sedimentologic and biogoechimcal connectivity between channels and floodplains. A growing recognition of the functions that seasonal floodplain wetlands provide has prompted global interest in the restoration and rehabilitation of many of these degraded ecosystems. While restoration activities are abundant, sound scientific basis for various actions, protocols for design, and post-project monitoring are generally lacking. Specifically, the effects of geomorphic channel restoration upon floodplain hydrology and wetland vegetation remain relatively un-documented.

Through assessment and modeling of an exceptionally well-documented stream restoration project, this research seeks quantitative answers to two fundamental questions: 1) what are the hydrologic effects of geomorphic restoration? It is widely believed that geomorphic channel restoration re-establishes the

hydrologic drivers that support floodplain wetlands. However, this has rarely been demonstrated or quantified. 2) How will these hydrologic changes impact the distribution of native wetland plant species? This also is assumed to be a direct benefit of geomorphic restoration, but is rarely assessed.

The proposed research will focus on a recently restored meadow reach of Bear Creek, the most significant tributary to the Fall River, Shasta County, California. The research plan involves two, linked programs, hydrology and vegetation response. Research and modeling efforts will be conducted by Christopher Hammersmark, Ph.D. candidate in Hydrologic Sciences at UC Davis.

1) Hydrology - In order to quantify the impact of restoration activities on hydrologic storage and fluxes, a hydrologic model will be developed. A two-dimensional hydraulic model, coupled with a three-dimensional subsurface model, will be used to simulate the hydrologic connectivity of the restoration site comparing the pre- and post-project topographic conditions. Data describing the hydrologic fluxes (groundwater, surface water, evapotranspiration and precipitation), subsurface characterization and land surface topography are necessary to successfully simulate the integrated ground/surface water system. The required data is currently being collected at the field site. Pre- and post-project topography have been collected and will be used to simulate the two conditions, with identical hydrologic boundary condition data. Simulation results will be compared using an Index of Hydrologic Alteration (IHA) approach, comparing the magnitude, frequency, duration and rate of change of various flow events. This effort will allow a quantification of changes in water balance associated with geomorphic channel restoration.

2) Vegetation Response - The distribution of floodplain wetland plants is controlled by many factors including the availability of suitable substrate, seed sources, duration of inundation, protection from scouring flows in addition to the access to and rate of change of shallow groundwater. To evaluate the change in wetland plant distribution based upon hydrologic parameters, a probabilistic vegetation model will be coupled to the hydrologic model described above using a gradient analysis. Vegetation will be sampled in regions, which have not experienced significant change in flooding and depth to groundwater due to restoration efforts in order to build the vegetation model. Vegetation data will be classified into community types using Two-Way Indicator Species Analysis (TWINSPAN), and a habitat suitability statistical approach will be used to determine the distribution of various community types throughout the restored meadow as a function of depth to groundwater during the growing season, protection from scouring flows, and rate of change of the water table. The coupled hydrologic-vegetation model will be used to simulate the effect of the restoration upon the availability of suitable physical habitat for native species and the spatial extent of various plant communities will be compared.

Results of the coupled ecohydrologic modeling effort will provide a better understanding of the potential impacts of geomorphic restoration upon native wetland plant distribution to help guide future restoration efforts aimed at the conservation of rare, threatened, and endangered species. The results of the study will benefit land managers, restoration practitioners and regulators by establishing baseline information regarding the potential benefits of stream restoration, as well as developing new predictive tools to assess potential design considerations.
